PESTICIDE CONCENTRATIONS IN SOME SOUTH AUSTRALIAN BIRDS AND OTHER FAUNA

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Summary

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Data are provided for concentrations of the pesticides DDT plus metabolites, HCB, lindane, aldrin and dieldrin present in tissues of 20 native and two exotic bird species, one freshwater crustacean, one amphibian, two reptiles (lizards) and two exotic mammals from Saddleworth-Riverton survey, 1972; 18 native and two exotic bird species from miscellaneous areas, 1968–74; eggs of 23 native and two exotic bird species from miscellaneous areas 1971; and 26 foxes from miscellaneous areas, 1973.

Key Words: Organochlorine pesticides, Aves, Reptilia Amphibia, Crustacea, exotic Mammalia, South Australia.

Introduction

There is a paucity of published data on pesticide contamination in Australian fauna. In Victoria, 24 widely separated areas, each covering about 9300 ha, were surveyed for determination of concentrations of pesticides in 63 bird species, 10 mammal species, 15 fish species and eggs of 14 different birds (Butcher 1967; Australian Academy of Science 1972). In the Northern Territory Best (1973) surveyed the organochlorine pesticide residues in the fatty tissues of 12 mammal, four bird, ten reptile and six fish species from undeveloped and developed areas in arid and tropical zones.

The Australian Academy of Science (1972) reported ranges in concentrations of DDT plus metabolites in the Namoi cotton growing region for waters of creeks and rivers and their sediments, algae, crustaceans, fish, birds and turtles together with the range in concentrations of 29 fat samples from ten species of birds of the Bathurst area.

Olsen & Settle (1979) when reporting on the pesticide contamination in various tissues of water rats in the Murrumbidgee Irrigation Area, N.S.W. 1970–72 indicated that "little is known of the pesticide contamination of Australian fauna".

The South Australian Pesticides Advisory Committee was concerned about the lack of data on the concentrations of pesticide residues in fauna and the implications of this for research planning. As a consequence, in mid 1971, programmes to obtain these much needed baseline data were commenced. The Department of Fisheries and Fauna Conservation arranged for eggs of a number of bird species to be collected in the spring of 1971 while officers of the Department of Agriculture undertook the collection of representative fauna in a selected area in January 1972.

Broad surveys to determine concentrations of pesticides in native and exotic avi-fauna and some other terrestial fauna from selected areas in South Australia were undertaken between 1971 and 1973. Determinations of pesticide residues in birds suspected of pesticide poisoning were carried out between 1968 and 1974.

History of Pesticide use — Saddleworth-Riverton area

pp'DDT

This area was selected because of the relatively high DDT usage for control of pea weevil (*Bruchus pisorum*) and native budworm (*Heliothis punctiger*) in field pea crops. As it is usual to have a 7–8 year crop rotation and the average annual area sown to peas is about 3%, it follows that about 20% of the total area of over 5000 ha would have received direct applications of about 1.5 kg/ha of pp'DDT in the 8-year period prior to 1971. The area has an annual rainfall of about 500 mm.

In October 1971, 150 hectares of field peas were treated with pp'DDT; 40 ha were sprayed with 0.7 kg/ha pp'DDT in early October and a second spraying, at the same concentration was given later in the month whilst the 109 ha paddock of peas was sprayed once with 1.05 kg/ha pp'DDT. Thus a total of approx. 170 kg of pp'DDT was applied over 150 ha three months before the fauna sampling study was commenced in late January 1972. Lucerne growing in the area was not sprayed.

Lindane

The only report of the use of lindane in the Saddleworth-Riverton area was as lindane-

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TABLE 1. *Fauna Pesticide Concentrations — Saddleworth-Riverton Area, January-February 1972§*

Common name	Scientific name	Saddleworth Distance–Direction	Habitat	Tissue	Pesticide (mg/kg wet weight)							
					HCB	LINDANE	ALDRIN	DIELDRIN	pp' DDT	DDD	DDE	DDT plus metabolites
White-faced heron	*Ardea novaehollandiae*	3 km NNE	p	l	0.09	0.06	*	*	*	*	46.7	46.7
Australian kestrel	*Falco cenchroides*	5 km ENE	p	l	0.03	*	*	*	*	*	3.94	3.94
Feral pigeon	*Columba livia*	0.5 km NNE	p	l	0.01	0.03	*	*	0.13	0.66	1.68	2.47
Crested pigeon	*Ocyphaps lophotes*	5 km ESE	r.v.	l	0.008	*	*	1.2	*	*	0.34	0.34
Galah	*Cacatua roseicapella*	3 km NNE	p	l	0.01	0.02	*	*	*	*	6.0	6.0
Galah	*Cacatua roseicapella*	12 km NNE	r.v.	s	0.05	0.03	*	*	0.4	*	4.3	4.7
Cockatiel	*Nymphicus hollandicus*	3 km NNE	p	b	0.01	*	0.53	0.29	*	*	0.33	0.33
Cockatiel	*Nymphicus hollandicus*	3 km NNE	p	b	0.03	0.03	*	0.05	0.4	0.2	0.9	1.5
Cockatiel	*Nymphicus hollandicus*	3 km NNE	p	b	0.04	0.07	*	0.5	0.5	0.16	0.5	1.16
Red rumped parrot	*Psephotus haematonotus*	3 km NNE	p	b	0.03	0.10	0.71	0.29	0.18	*	0.23	0.41
Red rumped parrot	*Psephotus haematonotus*	2 km NNE	p	b	0.05	0.11	*	*	0.43	*	3.55	3.98
Red rumped parrot	*Psephotus haematonotus*	3 km NNE	p	b	0.13	0.31	*	1.3	3.0	0.8	5.8	9.6
Red rumped parrot	*Psephotus haematonotus*	3 km NNE	p	b	0.01	0.03	*	0.36	0.22	0.11	0.34	0.67
Red rumped parrot	*Psephotus haematonotus*	5 km NNE	r.v.	b	0.02	0.10	*	0.2	0.2	*	0.4	0.6
Red rumped parrot	*Psephotus haematonotus*	7 km NNE	r.v.	b	0.02	*	*	0.13	0.08	*	0.38	0.46
Laughing kookaburra	*Dacelo novaeguineae*	5 km ESE	u.l.	s	0.11	*	*	*	0.35	0.13	7.2	7.68
Willie wagtail	*Rhipidura leucophrys*	3 km NNE	p	b	0.02	0.10	*	*	1.8	0.4	14.2	16.4
Willie wagtail	*Rhipidura leucophrys*	3 km NE	p	b	0.03	*	*	*	0.8	0.3	60.8	61.9
Hooded robin	*Melanodryas cucullata*	4 km ESE	u.l.	b	0.05	*	*	*	1.2	0.5	14.5	16.2
Brown treecreeper	*Climacteris picumnus*	6 km ENE	p	b	0.05	0.12	*	1.5	0.8	0.4	8.2	9.4
Brown treecreeper	*Climacteris picumnus*	6 km NE	r.v.	b	0.111	*	*	*	2.0	0.7	16.1	18.8
Striated pardalote	*Pardalotus striatus*	3 km NNE	p	b	0.01	0.02	*	*	10.3	1.1	27.6	39.6
Striated pardalote	*Pardalotus striatus*	5 km SE	u.l.	b	0.05	0.27	*	*	2.2	0.6	12.4	15.2
Striated pardalote	*Pardalotus striatus*	5 km ESE	u.l.	b	0.028	0.16	*	1.1	0.5	1.0	6.5	8.0
White-plumed honeyeater	*Lichenostomus penicillata*	5 km NE	r.v.	b	0.09	0.14	*	1.1	0.2	0.3	5.0	5.5
White-plumed honeyeater	*Lichenostomus penicillata*	3 km E	r.v.	b	0.05	0.30	*	*	0.3	0.3	12.6	13.2
Brown-headed honeyeater	*Melithreptus brevirostris*	3 km E	r.v.	b	0.04	0.20	*	1.3	0.5	0.3	7.3	8.1
Noisy miner	*Manorina melanocephala*	3 km NNE	p	b	0.10	0.05	1.56	*	*	*	16.3	16.3
Noisy miner	*Manorina melanocephala*	2 km E	r.v.	b	0.05	*	*	*	0.3	0.4	13.8	14.5
Noisy miner	*Manorina melanocephala*	3 km NNE	r.v.	b	0.06	0.06	*	*	0.2	*	33.0	33.2
House sparrow	*Passer domesticus†*	3 km NE	p	b	0.02	0.05	*	*	9.0	3.3	270	282.3
Magpie-lark	*Grallina cyanoleuca*	0.5 km NE	p	l	0.09	*	*	*	8.7	28.1	112	148.8
White-winged chough	*Corcorax melanorhamphos*	3 km E	r.v.	l	0.15	*	*	1.0	0.2	0.4	1.3	1.9
White-winged chough	*Corcorax melanorhamphos*	3 km E	r.v.	l	0.14	*	*	1.5	0.2	0.5	1.4	2.1
White-browed woodswallow	*Artamus superciliosus*	5 km NE	r.v.	b	0.07	*	*	*	*	*	8.0	8.0
Black-faced woodswallow	*Artamus cinereus*	6 km NE	r.v.	b	0.13	*	*	*	2.2	0.4	41.2	43.8
Australian magpie	*Gymnorhina tibicen*	3 km NNE	p	l	0.03	*	*	*	1.0	0.8	94.0	95.8
Australian magpie	*Gymnorhina tibicen*	0.5 km E	p	s	0.36	0.20	*	*	9.5	0.5	15.3	25.3
Little raven	*Corvus mellori*	3 km NNE	r.v.	s	0.24	0.11	*	*	8.4	0.8	29.8	39.0

TABLE 1. *Fauna Pesticide Concentrations — Saddleworth-Riverton Area, January-February 1972*§

Common name	Scientific name	Saddleworth Distance-Direction	Habitat	Tissue	Pesticide (mg/kg wet weight)							
					HCB	LINDANE	ALDRIN	DIELDRIN	pp' DDT	DDD	DDE	DDT plus metabolites
Yabbie	*Cherax destructor*	3 km NE	d	m	0.004	*	*	*	*	*	0.4	0.4
Marbled frog (juv)	*Limnodynastes tasmaniensis*	3 km NE	d	b	*	*	*	*	*	*	0.5	0.5
Marbled frog (adult)	*Limnodynastes tasmaniensis*	3 km NE	d	b	0.007	*	*	0.4	*	*	0.1	0.1
Dragon lizard	*Amphibolurus barbatus*	3 km E	r.v.	s	*	*	*	*	*	*	*	*
Skink	*Morethia boulengeri (?)*	5 km NE	r.v.	b	*	*	*	*	*	*	0.1	0.1
Hare	*Lepus capensis*	6 km NE	r.v.	k	*	*	*	*	*	*	0.2	0.2
Fox (juv)	*Vulpes vulpes*	5 km NE	r.v.	k	*	*	*	*	*	*	*	*

* Not detected. † Exotic species. § After Lim, Y. P. Unpublished Report 1972, Dept. of Agriculture, Adelaide.

Tissue
l – liver
s – stomach fat
b – body fat
m – muscle
k – kidney fat

Habitat
p – cleared land
r.v. – roadside vegetation
u.l. – uncleared land
d – dam

superphosphate for the control of redlegged earthmite (*Halotydeus destructor*) and for pests of germinating cereals in May to July 1971.

Dieldrin

The use of this organochlorine compound for pasture or crop spraying was discontinued in the Saddleworth-Riverton area in 1967.

HCB

The only use of HCB was as a seed dressing and its use and availability ceased in 1972.

Methods

All bird and mammal specimens in the Saddleworth-Riverton area were taken by shooting with 0.410 gauge shotgun or 0.22 calibre rifle whereas the lizards, frogs and yabbies were taken alive. All specimens showed normal behaviour at the time of collection.

All dead specimens were placed individually in polythene bags approved by the Chemistry Division, Department of Services and Supply. The specimens were labelled and packed in ice for delivery to Department of Fisheries and Fauna Conservation for identification checks before being sent for analysis by gas liquid chromatography in the Chemistry Division. Limits of detection were HCB 0.007 mg/kg, lindane 0.01 mg/kg, dieldrin 0.01 mg/kg, DDE 0.01 mg/kg, DDD 0.05 mg/kg, pp'DDT 0.07 mg/kg.

Some bird specimens were badly damaged by shot and for that reason only the available parts of the bodies were used in the analysis. The wings and feathers of all birds were removed before extraction.

Some data on pesticides residues in a few native birds from miscellaneous areas taken incidentally in the course of other studies as well as results of analyses of birds forwarded for examination by interested people suspecting that the birds may have died from pesticide poisoning were obtained.

A limited sampling of birds' eggs for pp'DDT plus metabolites was undertaken in the spring of 1971. Single eggs from clutches of two or more eggs were collected from a wide range of habitats extending from Lyndhurst in the north of the State to Lucindale in the south-east by H. J. Morton of Jervois. No shell thickness measurements were made.

During 1973 the Animal Health Branch, Department of Agriculture, carried out a survey of the intestinal parasites of foxes, the animals being taken from widely scattered districts throughout the State. The Pesticides Committee requested that samples of fat adhering to the kidney be taken for pesticide analysis.

Results

Saddleworth-Riverton area

Table 1 shows individual pesticide concentrations in the fauna examined from the Saddleworth-Riverton area.

The metabolite DDE was present in all birds while the parent pp'DDT was present at low concentrations or absent.

The rearrangement of the data in descending order of DDT plus metabolites (Table 2) indicates that pesticide concentrations were extremely variable, the highest and lowest were in grain feeding species. However, the high concentration in the house sparrow (a grain feeder) and the lower levels in the laughing kookaburra and the Australian kestrel (meat-eaters) demonstrate the need for more data before a relationship can be postulated between residues and diet.

In most cases, those species which are known from data of the Australian Bird Banding Scheme to show least movement from banding sites, were those which had the higher concentrations of pesticides in their tissues.

Miscellaneous areas

The analyses of 35 birds representing 21 species from miscellaneous areas (Table 3) showed that 14 birds had concentrations above 1 mg/kg DDT plus metabolites, two birds had above 0.5 but less than 1.0 mg/kg and 19 birds had less than 0.5 mg/kg in various body tissues.

The two highest concentrations were in birds forwarded by concerned people who considered that the birds may have died from pesticide poisoning. A grey butcherbird (281 mg/kg), which came from a farm on Eyre Peninsula, is believed to have died from eating field mice from a grain store which had been dusted with pp'DDT for rodent control during the 1970 mouse plague. Even then the use of pp'DDT as a rodenticide was not officially approved or recommended. Likewise the sacred kingfisher from Rendelsham (South-East) with a concentration of 75.6 mg/kg DDT plus metabolites, was suspected by the finder, of poisoning from pesticides.

The next highest concentrations were in an Australian pelican (9.41 mg/kg); a little penguin (5.2 mg/kg); a stubble quail (4.2 mg/kg); another two little penguins (4.0 and 3.8 mg/kg respectively) and a darter (3.78 mg/kg) all of which were collected opportunistically. Four young little penguins came ashore with oil soaked bodies; they were starving. Because of the scarcity of their body fat, oil from the preening gland was used in the analyses.

It is doubtful whether the presence of pp'DDT was responsible for the deaths of birds from home

TABLE 2. *Descending order of concentrations of DDT plus metabolites in birds — Saddleworth-Riverton area 1972*

Species	Prime-Food*			Concentration (mg/kg — wet weight)		
	Invert-ebrates	Small Animals	Seeds Fruits	Max	Other	Fat Tissue
House sparrow			+	282.3		body
Magpie-lark	+		+	148.8		liver
Australian magpie	+	+	+	95.8		liver,
					25.3	stomach
Willie wagtail	+			61.9	16.2	body(2)
White-faced heron	+	+		46.7		liver
Blackfaced wood-swallow	+	body		43.8		
Striated pardalote	+		+?	39.0	15.2, 8.0	body(3)
Little raven	+	+	+	39.0		stomach
Noisy miner	+		+?	33.2	16.3, 14.5	body(3)
Brown treecreeper	+			18.8	9.4	body(2)
Hooded robin	+			16.2		body
White-plumed honeyeater	+			13.2	5.5	body(2)
Red-rumped parrot			+	9.6	3.98, 0.67, 0.6, 0.46, 0.41	body(6)
Brown-headed honeyeater	+			8.1		body
White-browed swallow	+			8.0		body
Laughing kookaburra	+	+		7.68		stomach
Galah			+	6.0		liver
Galah					4.7	stomach
Australian kestrel	+	+		3.94		liver
Feral pigeon			+	2.47		liver
White-winged chough	+		+	2.1	1.9	liver(2)
Cockatiel			+	1.5	1.16, 0.33	body(3)
Crested pigeon			+	0.34		liver

(after Lim 1972 see Table 1)

* Invertebrates = insects, crustaceans, and some molluscs. Small animals = fish, frogs, lizards and young birds. Seeds and fruits = includes bulbs and such like underground plant storage tissues. (0) Number of birds examined.

gardens in various areas of the State (Table 3) when apparently healthy birds of the same species with much higher concentrations of the pesticide were surviving without showing any stress symptoms (Table 2). In post-mortem examinations of the cormorants and the pelican by veterinarians, death was ascribed to respiratory infections.

Twenty-six eggs of 23 species (21 native species) were examined and no evidence of pp'DDT or metabolites was found in eggs from eight species. Another eight species had a range of concentrations from 0.01 to 0.10 mg/kg DDT plus metabolites, whereas seven species had eggs with concentrations between 0.12 and 0.50 mg/kg. Eggs of three species had concentrations above 0.5 mg/kg, namely a butcherbird (1.34 mg/kg), a brown thornbill (0.69 mg/kg) and a superb fairy-wren (0.62 mg/kg). All three species came from near cleared cultivated areas.

Three species had eggs taken from separate nests at different times. In the black-faced cuckoo-shrike from two widely separated areas, the Beltana egg sample from the earlier brood had no pesticides present whereas the Finnis sample of November had a concentration of 0.50 mg/kg DDT plus metabolites. Two eggs from different broods of the superb fairy-wren had a five-fold difference in concentration (0.12 to 0.62 mg/kg) of the pesticide. On the other hand the concentrations of DDT plus metabolites in broods of the two rainbow bee-eaters, taken six weeks apart at Tailem Bend were virtually identical (0.03 and 0.02 mg/kg respectively). Most birds, whose broods were sampled, are predominantly insect and arthropod eaters and only a few cockatoos supplement their diet with seeds while two species, the common bronzewing and little quail have seeds as their prime food.

In the bird broods sampled (Table 4) those eggs with the nil or lowest concentrations of pesticides came from nests in the lower rainfall areas. Those birds with the higher concentration of DDT plus metabolites were from higher rainfall areas and hence more closely settled districts where cropping practices were more intensive.

In only two of the 26 foxes was the sex recorded and no observations were given on the estimated

TABLE 3. *Pesticide concentrations in birds — miscellaneous areas.*

Common name	Scientific name	Date Collected	Area	Habitat	Tissue Examined	Pesticide (mg/kg wet weight)						
						HCB	LINDANE	DIELDRIN	pp'DDT	DDD	DDE	DDT plus metabolites
Little penguin (adult)	*Eudyptula minor*	20.v.71	Penguin Island (SE)	burrow	b	*	*	*	0.2	*	1.2	1.4
					l	*	*	*	*	*	*	*
					prg.	*	*	*	0.1	*	0.5	0.6
Little penguin (juv.)	*Eudyptula minor*	19.v.71	Robe	beach	prg.	*	*	*	0.4	*	3.6	4.0
Little penguin (juv.)	*Eudyptula minor*	19.v.71	Robe	(oil soaked)	prg.	*	*	*	0.3	*	4.9	5.2
Little penguin (juv.)	*Eudyptula minor*	19.v.71	Robe	(oil soaked)	prg.	*	*	*	0.3	*	3.5	3.8
Little penguin (juv.)	*Eudyptula minor*	19.v.71	Robe	(oil soaked)	prg.	*	*	*	0.2	*	0.8	1.0
Stubble quail	*Coturnix novaezelandiae*	24.i.72	4 km E. Moonta	pasture stubble	b	*	*		*	*	1.43	1.43
Stubble quail	*Coturnix novaezelandiae*	24.i.72	4 km E. Moonta	pasture stubble	b	*			*	*	4.2	4.2
Stubble quail	*Coturnix novaezelandiae*	24.i.72	4 km E. Moonta	pasture stubble	b	0.01			*	*	1.47	1.47
Crested pigeon (juv.)	*Ocyphaps lophotes*	Oct. 1971	Adelaide	park-lands†	b				*	*	0.02	0.02
Great cormorant	*Phalacrocorax carbo*	22.ii.70	Moorook	river swamp‡	br				0.07	0.09	0.10	0.26
					l				0.02	0.02	0.02	0.06
					b				0.03	0.04	0.17	0.24
Great cormorant	*Phalacrocorax carbo*	22.ii.70	Moorook	river swamp‡	b				0.09	0.12	0.18	0.39
					l				0.04	0.05	0.05	0.14
					b				0.04	0.05	0.07	0.16
Great cormorant	*Phalacrocorax carbo*	3.viii.70	near Moorook	river swamp‡	l	*		*				0.18
Great cormorant	*Phalacrocorax carbo*	3.viii.70	near Moorook	river swamp‡	l	*	*	*				0.06
Great cormorant	*Phalacrocorax carbo*	3.viii.70	near Moorook	river swamp‡	l	*	*	*				0.08
Darter	*Anhinga melanogaster*	13.xi.69	near Barmera	river swamp†	b	0.021	*	0.53	0.14	0.08	3.56	3.78
							0.02					
Australian pelican	*Pelecanus conspicillatus*	20.ii.70	Lake Bonney	lake area‡	b	*	*	*	0.24	3.96	5.21	9.41
Gannet	*Sula serrator*	19.v.71	Robe	beach‡	l	*		*	0.1		1.3	1.4
Straw-necked ibis (juv.)	*Threskiornis spinicollis*	28.iii.69	Bool Lagoon	marsh‡	d.o.	*	*	*			*	*
							*					
Musk duck	*Biziura lobata*	28.iii.69	Bool Lagoon	marsh‡	br	*		*			*	*
Musk duck	*Biziura lobata*	28.iii.69	Bool Lagoon	marsh‡	br	*		*			*	*
Horsfield's bronze-cuckoo	*Chrysococcyx basalis*	28.vi.68	Loxton	country garden†	br d.o.			*	*		*	*
Sacred kingfisher	*Halycon sancta*	20.xi.71	Rendelsham	home garden†	b	0.03			1.3	1.9	72.4	75.6
							0.1					
Welcome swallow	*Hirundo neoxena*	16.x.60	Naracoorte	home garden‡	b			1.6				0.8
Willie wagtail	*Rhipidura leucophrys*	11.iii.70	Adelaide Hills	bush-land	b	*			0.01		0.31	0.32
							*					
Silvereye	*Zosterops lateralis*	July 1974	Campbelltown	home garden†	b	0.005		0.04	0.13	0.02	2.20	2.35
							0.016					

TABLE 3. *Pesticide concentrations in birds — miscellaneous areas.*

Common name	Scientific name	Date Collected	Area	Habitat	Tissue Examined	Pesticide (mg/kg wet weight)						
						HCB	LINDANE	DIELDRIN	pp'DDT	DDD	DDE	DDT plus metabolites
Red wattlebird	*Anthochaera carunculata*	24.ix.68	Toorak Gardens	home garden‡	br	*	*	*	*		0.20	0.20
Red wattlebird	*Anthochaera carunculata*	24.ix.68	Toorak Gardens	home garden‡	d.o.	*	*	*	*		0.23	0.23
Red wattlebird	*Anthochaera carunculata*	24.ix.68	Toorak Gardens	home garden‡	d.o.	*	*	*	*		*	*
White-browed babbler	*Pomatostomus superciliosus*	28.vi.68	Berri	country garden‡ (died in spasm)	br d.o.			*	*		0.30 0.10	0.30 0.10
Australian magpie	*Gymnorhina tibicen*	Oct. 1968	Adelaide Hills	home garden‡	b	"Endrin" 1.8		2.0	*			*
Apostle bird	*Struthidea cinerea*	28.vi.68	Berri	country garden‡	br d.o.			*	*	*	0.3	0.3
Grey butcherbird	*Cracticus torquatus*	3.viii.70	Eyre Peninsula	farm-yard‡	l				43.0	156.0	82.0	281.0
House sparrow	*Passer domesticus*†	July 1974	Campbelltown	home garden‡	b	0.003		0.01	0.012	0.016	60.42	0.448
Common starling	*Sturnus vulgaris*†	July 1974	Campbelltown	home garden‡	d.o.	0.004	0.005	0.025	0.011	0.006	0.59	0.607
Common starling	*Sturnus vulgaris*†	July 1974	Campbelltown		d.o.	0.006	0.004	0.024	<0.010	0.012	0.39	0.402

* Not detected
† Exotic species
‡ Found dead or dying
b = body fat
l = liver
pr.g. = preening gland
br = brain
d.o. = digestive organs

TABLE 4. *Descending order of concentrations of DDT plus metabolites in eggs — miscellaneous areas.*

Common name	Scientific name	Date collected	Area	Concentration (mg/kg wet weight)				Approx. average annual rainfall (mm)
				pp'DDT	DDD	DDE	DDT plus metabolites	
Grey butcherbird	*Cracticus torquatus*	8.xi.71	Swede Flat	*	*	1.34	1.34	530
Brown thornbill	*Acanthiza pusilla*	7.x. 71	Lucindale	0.09	0.04	0.56	0.69	620
Superb fairy-wren	*Malurus cyaneus*	7.x. 71	Lucindale	0.06	0.05	0.51	0.62	620
Black-faced cuckoo-shrike	*Coracina novaehollandiae*	5.xi.71	Finnis	*	*	0.50	0.50	450
Eastern yellow robin	*Eopsaltria australis*	7.x. 71	Lucindale	0.04	0.03	0.22	0.29	620
Grey fantail	*Rhipidura fuliginosa*	7.x. 71	Lucindale	*	*	0.18	0.18	620
Blackbird	*Turdus merula*†	16.x. 71	Jervois	*	*	0.17	0.17	360
Superb fairy-wren	*Malurus cyaneus*	14.xi.71	Salt Creek	*	*	0.12	0.12	490
Silvereye	*Zosterops lateralis*	12.xi.71	Bakers Range	*	*	0.12	0.12	610
Noisy miner	*Manorina melanocephala*	10.xi.71	Swede Flat	*	*	0.12	0.12	530
White-throated treecreeper	*Climacteris leucophaea*	16.x. 71	Willunga	*	*	0.08	0.08	650
Purple swamphen	*Porphyrio porphyrio*	24.x. 71	Lucindale	*	*	0.06	0.06	620
Diamond firetail	*Emblema guttata*	27.x. 71	Tailem Bend	*	*	0.06	0.06	385
Striated grasswren	*Amytornis striatus*	7.xi.71	Murray Bridge	*	*	0.05	0.05	344
Grey shrike-thrush	*Colluricincla harmonica*	11.xi.71	Bakers Range	*	*	0.04	0.04	610
Rainbow bee-eater	*Merops ornatus*	9.x. 71	Tailem Bend	*	*	0.03	0.03	380
Rainbow bee-eater	*Merops ornatus*	28.xi.71	Tailem Bend	*	*	0.02	0.02	380
European goldfinch	*Carduelis carduelis*†	10.x. 71	Jervois	*	*	0.01	0.01	360
Little quail	*Turnix velox*	18.x. 71	Lyndhurst	*	*	*	*	175
Common bronzewing	*Phaps chalcoptera*	28.xi.71	Tailem Bend	*	*	*	*	385
Yellow-tailed black-cockatoo	*Calyptorhynchus funereus*	27.xi.71	Spring Hill	*	*	*	*	580
Black-faced cuckoo-shrike	*Coracina novaehollandiae*	12.x. 71	Beltana	*	*	*	*	209
Little grassbird	*Megalurus gramineus*	19.x. 71	Orroroo	*	*	*	*	341
Masked woodswallow	*Artamus personatus*	13.x. 71	Edeowie	*	*	*	*	300
Red-browed firetail	*Emblema temporalis*	20.xi.71	Nangkita	*	*	*	*	750
Chirruping wedgebill	*Psophodes cristatus*	13.x. 71	Lyndhurst	*	*	*	*	174

* Not detected † Exotic species

ages of the foxes i.e. juvenile or adult. The foxes were taken in the course of a tapeworm survey and it is presumed they were mostly older animals and not pups.

HCB

All 26 samples of fox kidney fat showed traces of HCB. Thirteen foxes showed the presence of dieldrin in the kidney fat. The highest concentration of 0.67 mg/kg was present in a fox from Mannum district, the next highest was 0.27 mg/kg in a fox from the Port Lincoln area (Table 5). The remaining 11 foxes had concentrations ranging from 0.02 to 0.16 mg/kg dieldrin. Six only of the 26 foxes examined showed the presence of pp'DDT or metabolites, the highest concentration of 1.34 mg/kg was in the same fox from Mannum which registered the highest concentration of dieldrin.

Discussion

The amounts of pp'DDT used in the Saddleworth-Riverton area were believed to be the highest used anywhere in South Australia at that time and survey results from that area were considered likely to show the highest residues from DDT in this State. The annual application of about 1.5 kg/ha of pp'DDT to about three percent of the area is not high compared with application rates of four to six times heavier on greater areas of cotton and tobacco planted elsewhere in Australia (Australian Academy of Science 1972).

The data on pesticide residues in Australian fauna is limited to small numbers of some of the more common species present in different areas. Comparison of residues is difficult because of different tissues analysed.

Of the 38 native and four exotic bird species from South Australia, only 12 native and one exotic species were common to the 63 species previously surveyed in Victoria (Australian Academy of Science 1972). Table 6 shows these in descending order of maximum concentrations of DDT plus metabolites found in any tissues.

The highest concentration, 160 mg/kg was in the body fat of an Australian kestrel and was also the highest level recorded in six other raptor species from Victoria. Best (1973) reported up to 12.15 mg/kg wet weight in bulked samples of body fat of fork tailed (black) kites, raptors from the N.T. The recording of 3.94 mg/kg in the Australian

TABLE 5. *Concentrations of pesticides in fat of foxes — miscellaneous areas — 1973.*

Date received	Town or district	Pesticide (mg/kg wet weight)					DDT plus metabolites
		HCB	DIELDRIN	pp'DDT	DDE	DDD	
8-i-73	Port Lincoln	0.006	0.06	*	*	*	*
13-i-73	Port Lincoln	0.007	0.06	*	*	*	*
13-i-73	Port Lincoln	0.007	0.06	*	*	*	*
25-i-73	Port Lincoln	0.05	0.14	*	0.08	*	0.08
19-ii-73	Port Lincoln	0.001	0.27	*	0.02	*	0.02
25-v-73	Port Lincoln	0.02	*	0.11	0.26	*	0.37
28-v-73	Port Lincoln	0.18	*	*	*	*	*
6-vi-73	Port Lincoln	0.21	*	*	0.18	*	0.18
16-vi-73	Murray Bridge	0.31	0.05	*	*	*	*
16-vi-73	Murray Bridge	0.006	*	*	*	*	*
16-vi-73	Mount Gambier	0.002	*	*	*	*	*
25-vi-73	Port Lincoln	0.008	0.08	*	*	*	*
25-vi-73	Mount Gambier	0.005	*	*	*	*	*
25-vi-73	Mount Gambier	0.002	*	*	*	*	*
27-vi-73	Murraytown	0.008	*	*	*	*	*
27-vi-73	Murraytown	0.015	0.04	*	*	*	*
27-vi-73	Murraytown	0.014	0.02	*	*	*	*
2-vii-73	Port Lincoln	0.003	0.16	*	*	*	*
4-vii-73	Port Lincoln	0.004	*	*	*	*	*
18-vii-73	Mannum	0.028	0.06	*	*	*	*
18-vii-73	Mannum	0.091	0.67	0.50	0.75	0.09	1.34
26-vii-73	Port Lincoln	0.004	*	*	*	*	*
26-vii-73	Port Lincoln	0.004	*	*	*	*	*
26-vii-73	Port Lincoln	0.02	*	*	0.05	*	0.05
8-viii-73	Jamestown	0.007	0.10	*	*	*	*
8-viii-73	Hallet	0.009	*	*	*	*	*

* Not detected

TABLE 6. *Descending order of concentrations of DDT plus metabolites in 13 bird species common to South Australia and Victoria.*

Species	Maximum pesticide concentration mg/kg wet weight	
	South Australia	Victoria
Australian kestrel	3.94	160.0
Magpie lark	148.8	0.20
Australian magpie	95.8	26.0
White-faced heron	46.7	78.0
Little raven	39.0	0.36
Laughing kookaburra	7.68	20.0
Fairy penguin	5.2	14.0
Stubble quail	4.2	0.67
White-winged chough	2.1	0.09
Great (large black) cormorant	0.39	1.8
Welcome swallow	0.80	1.2
Red wattle bird	0.20	0.81
Starling	0.60	0.07

kestrel is the only measurement from a raptor species in S.A.

Although many waterbird species were examined for pesticides in Victoria, only the white-faced heron, the great (large black) cormorant and the fairy penguin were also examined in the South Australian studies and they had lower concentrations than their respective Victorian specimens.

In the Namoi cotton growing area of N.S.W., which had received the highest rates of application of pp'DDT in Australia (Australian Academy of Science 1972), seven cormorants had an average of 4.6 mg/kg (basis unspecified) in the body fat. Two great cormorants from Moorook, S.A., had 0.24 and 0.39 mg/kg wet weight in body fat whereas a Victorian great (large black) cormorant had 1.8 mg/kg wet weight in body fat.

Two quail from the Namoi area had an average of 0.45 mg/kg (basis unspecified) in body fat, three stubble quail from Moonta, S.A., had 1.43, 1.47 and 4.2 mg/kg wet weight in body fat and four stubble quail in Victoria had 0.67 and 0.14 mg/kg wet weight in fat.

Two galahs from Saddleworth-Riverton area had DDT residue concentrations of 4.7 and 6.0 mg/kg (stomach and liver fat respectively) whereas lower concentrations (0.22 to 3.69 mg/kg wet weight), were recorded in bulked samples of galahs from developed arid areas near Alice Springs and still lower concentrations (nil to 0.17 mg/kg) in bulked samples from undeveloped arid areas in the N.T. (Best 1973).

Freshwater crayfish from river and creek sources in the Namoi area had DDT residue concentrations ranging from 0.17 to 6.5 mg/kg, dry weight, and higher values between 13.8 and 54.7 mg/kg, averaging 29.9 mg/kg dry weight from specimens collected in irrigation drains (Australian Academy of Science 1972). A yabbie from a dam in the Saddleworth-Riverton area had a lower concentration of 0.4 mg/kg wet weight.

In the South Australian results, pesticide levels were generally higher in those bird species which feed on other animals, including insects, than in bird species which utilise food of vegetable origin, i.e. seeds, fruits, bulbs and other underground storage organs.

The lower proportion of pp'DDT than DDE present in the tissues is indicative of pesticides having been applied some time ago rather than of recent application. There was no apparent effect on the general well-being of the birds examined in the Saddleworth-Riverton survey although some, e.g. the sparrow, carried high concentrations of pesticide, particularly DDE. Davis (1967, 1974) drew attention to the wide variations in susceptibility of different bird species to specific pesticides and considered that lethal levels for a species may vary with conditions such as stress. From the high concentrations of pp'DDT plus metabolites in the butcher bird and its known contact with pp'DDT, it is presumed that this chemical caused its death. With the sacred kingfisher from Rendelsham, the cause of death is uncertain because there was no known association with pesticide application and it had lower concentrations of pesticides than three other apparently unaffected bird species with high pesticide concentrations in the Saddleworth-Riverton survey (Table 1).

In the species, other than birds, examined, concentrations of DDT plus metabolites were low. In foxes the low concentrations and absence (21 out of 27) was interesting particularly in view of the omnivorous diet of this species. Two foxes in the Northern Territory also had low concentrations of DDT residues (0.03 mg/kg) (Best 1973).

The DDT plus metabolites concentrations in eggs

of 23 South Australian bird species were relatively low. Eggs of seven species were free of pesticides, 13 species had concentrations of 0.5 mg/kg wet weight or less and the eggs of three species contained 1.34 mg/kg (grey butcherbird), 0.69 mg/kg (brown thornbill) and 0.62 mg/kg (superb fairy wren) (Table 4).

In the Victorian survey, eggs from nests of 14 different bird species, nine of which were water birds, contained DDT plus metabolites. Four of the species contained concentrations higher than values found in eggs of the 23 South Australian species. The eggs of a stilt had a concentration of 12 mg/kg wet weight, a whistling eagle 3.2 mg/kg, a little pied cormorant 2.5 mg/kg and a starling 1.70 mg/kg.

Because of wide differences in food preferences and feeding habits of birds from Victoria and those from S.A. there is no basis for comment except to record the concentrations of DDT plus metabolites found in the eggs of birds in these two surveys.

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ECHINOCEPHA LUS OVERSTREETI DEARDORFF & KO, 1983 (NEMATODA:GNATHOSTOMATOIDEA) FROM ELASMOBRANCHS AND MOLLUSCS IN SOUTH AUSTRALIA

BY IAN BEVERIDGE

Summary

Specimens of *Echinocephalus overstreeti* were found in the following elasmobranch and chaemeriform fishes from South Australia: *Heterodontus portusjacksoni* (Meyer, 1793), *Parascyllium ferrugineum* McCulloch, 1911, *Orectolobus maculatus* (Bonnaterre, 1788), *Myliobatis australis* Macleay, 1881, *Aptychotrema vincentiana* (Haacke, 1885), *Trygonorhina guanerius* Whitley, 1932, *Raja whitleyi* Iredale, 1938, *Urolophus mucosus* Whitley, 1939, *Dasyatis brevicaudatus* (Hutton, 1875), *D. thetidis* (Waite, 1899), *Hypnos rnonopterygium* (Shaw & Nodder, 1795) and *Callorhynchus milii* Bory de St Vincent, 1823. Gravid nematodes were found only in *H. portusjacksoni.* A redescription of the nematode is given and its differentiation from congeners discussed. Nematodes undergoing the final moult in elasmobranchs permitted the identification of the scallops *Pecten albus* Tate, 1887 and *Chlarnys bijrons* (Lamark, 1819) as possible intermediate hosts.

KEY WORDS: Nematoda, Gnathostomatoidea, *Echinocephalus,* morphology, life history.